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University of Ottawa
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School of Electrical
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Assignment 5

CSI2120 Programming Paradigms

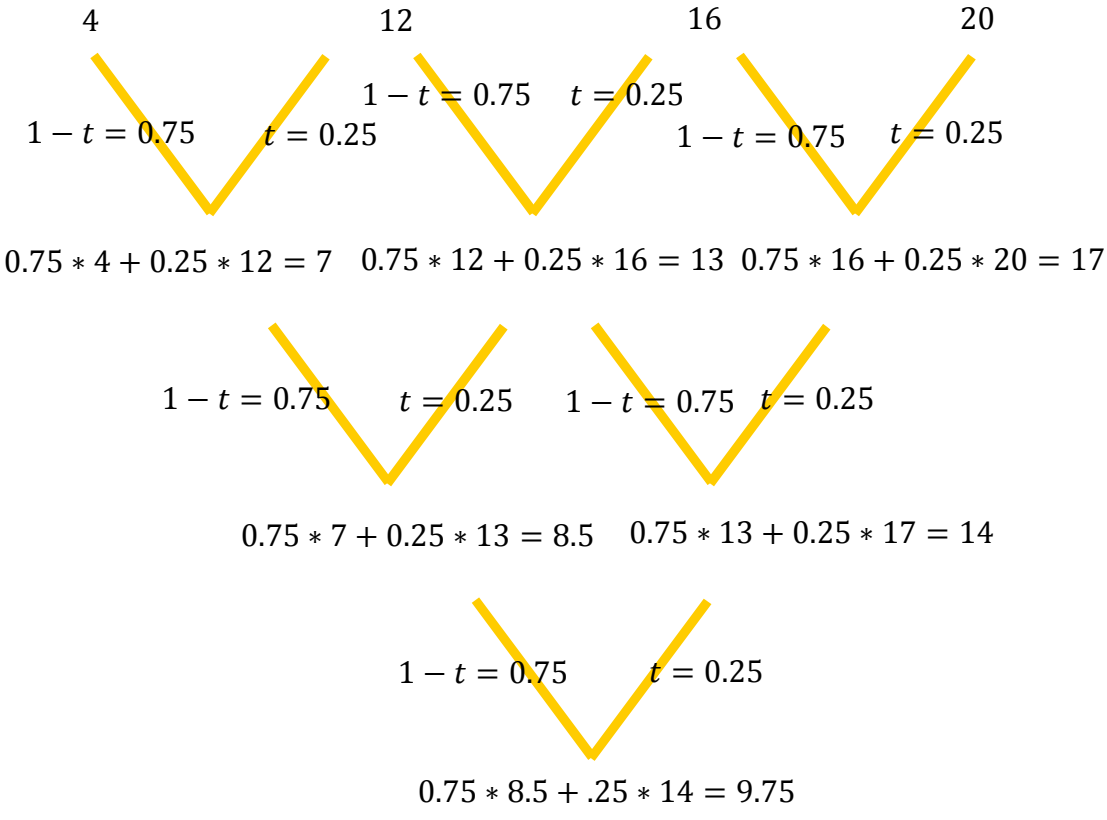
Winter 2017

Due on March 31st, 2017 before 11:00 pm in Virtual Campus

[5 marks in total]

Question 1. **De Casteljau Algorithm [3 marks]**

The De Casteljau algorithm calculates a free-form curve, called the Bezier curve. In this example, we use it for interpolation. We are interpolating the input point based on a curve parameter. We want to know all interpolated points at all levels. For simplicity, we use only one-dimensional points. Here is an illustration for four input points 4,12,16,20 and curve parameter $t = 0.25$.



a) Create a function `deCasteljau` that applies the De Casteljau algorithm to a list of numbers and returns a list of lists with the result. Example:

```
(deCasteljau 0.25 (4 12 16 20))
   ⇨ ((9.75) (8.5 14) (7 13 17) (4 12 16 20))
```

Note that your function must work for any length of input list. A list of 4 numbers will produce a list of 4 lists as a result, a list with 5 numbers will produce a list of 5 lists as a result and so on.

b) Modify your function from part a) using local bindings i.e., the appropriate form(s) of `let`. For this part of the question, you are not allowed to define any helper function through top-level defines. Use instead only local bindings. Example:

```
(deCasteljau-local 0.25 (4 12 16 20))
((9.75) (8.5 14) (7 13 17) (4 12 16 20))
```

Note that if your function `deCasteljau` is already not using any helper function but `let`, you may hand-in the same answer for a) and b).

Question 2. Vectors in Scheme [2 marks]

For this question, you are not allowed to convert the vector into a list.

The "0-norm" as used by Donoho for discrete vector is defined as the number of non-zero dimensions of a vector. For example, the vector $[3,0,2,-4,0,2]$ has a "0-norm" of 4, while the vector $[-5,0,0,1,0,0,0,0,-2]$ has a "0-norm" of 3.

a) Create a function `norm0` that calculates the "0-norm" for integer vectors. Example:

```
(norm0 #(3 0 2 4 0 2))
   ⇨ 4
```

Vector normalization is dividing each element of a vector by its norm. For example, the a normalization of the vector $[3,0,2,-4,0,2]$ with the "0-norm" produces the vector $[0.75,0,0.5,-1,0,0.5]$.

b) Create a function `normalize0` that normalizes a vector by its "0-norm" calculated in a). Example:

```
(norm0 #(3 0 2 -4 0 2))
   ⇨ #(0.75 0 0.5 -1 0 0.5)
```